Low Excited States of F^{19}. II. Lifetime Measurements*

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The lifetimes of the 114-kev and 200-kev excited states[1] of F^{19} have been measured by the recoil technique.[2]

For the lower state the apparatus described in reference 2 was employed. A CaF_2 target ($\sim$3 kev at 1 Mev for protons) was evaporated on a thin nickel foil. The incident proton energy was chosen to give an energy of 1431 kev after passing through the nickel foil. The results are shown in Fig. 1. Curve A is obtained when an additional nickel foil is placed over the CaF_2 layer to prevent recoils from leaving the target. It will be noted that the gamma-ray counting rate drops off completely for a movement of the target, relative to the gamma-ray collimator, of 0.1 mm. The experimental points on curve B are obtained when the recoils are free to leave the target. Because of the thinness of the CaF_2 layer employed, at least 75 percent of the recoils leave the target. The theoretical curves B, C, D, were computed, taking account of the isotropic distribution[1] of the inelastically scattered protons in the center-of-mass system, and the slowing down of the recoils in leaving the CaF_2 layer. (The layer is about 1/7 of the maximum range of the F^{19} recoils.) We conclude that the mean lifetime is $(1.0\pm0.25)\times10^{-9}$ sec. This value is in good agreement with that derived from the absolute cross section for excitation of this level of F^{19} by inelastic scattering of alpha particles, if the latter process is assumed to be electric dipole Coulomb excitation.[3] The transition probability is of the order of 100 times smaller than predicted by the single-particle formula.[4]

In the case of the 200-kev state, the F^{19} recoils (at the 1092-kev resonance) were collimated in a forward cone of half-angle 30°. The recoils were stopped on a plate 8 cm in diameter which could be observed through a collimated channel by a NaI(Tl) scintillation counter. The target was a layer $\sim$8 kev thick of aluminum fluoride formed by exposing the back of a 0.2-mg/cm² Al foil to HF vapor. The distance between the target and recoil stopper was varied from 2 to 12 cm. The resultant curve, Fig. 2, indicates a mean lifetime of 0.8×10^{-7} sec with an uncertainty of about a factor 2. The large uncertainty indicated is due to the low yield and the background produced by high-energy radiation. The lifetime for this state is in satisfactory agreement with that predicted by the Coulomb excitation work[3] on the basis of an electric quadrupole assignment to the gamma ray. The observed transition probability is of the order of magnitude of that predicted by the single-particle model for an electric quadrupole transition.[4]

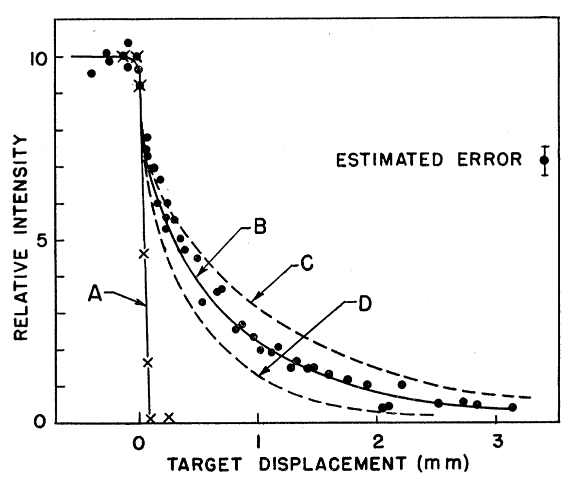

Fig. 1. Intensity of 114-kev gamma radiation as a function of the distance travelled by the fluorine recoils before radiating. Curve A is obtained by stopping all recoils at the target in an additional nickel foil. Curves B, C, and D are computed for mean lifetimes of 10^{-9} sec, 1.5×10^{-9} sec, and 0.66×10^{-9} sec, respectively.

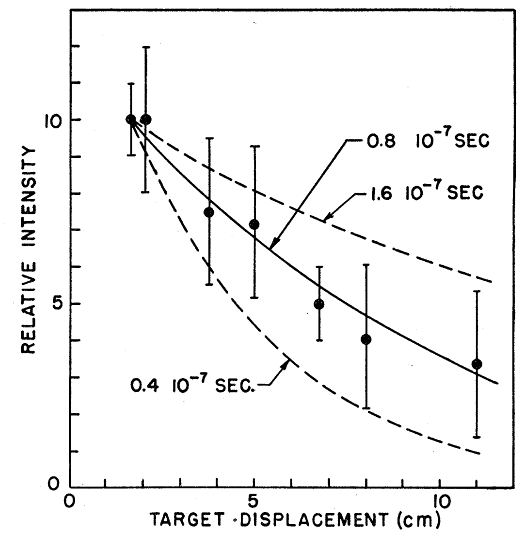

Fig. 2. Intensity of 200-kev gamma radiation as a function of the distance travelled by the fluorine recoils before radiating.

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[2] J. Thirion and V. L. Telegdi, Phys. Rev. **92**, 1253 (1953).
[3] Sherr, Li, and Christy, following Letter [Phys. Rev. **94**, 1076 (1954)].
[4] V. F. Weisskopf, Phys. Rev. **83**, 1073 (1951); S. A. Moszkowski, Phys. Rev. **89**, 474 (1952); B. Stech, Z. Naturforsch. **7a**, 401 (1952).

Low Excited States of F^{19}. III. Coulomb Excitation by α Particles*

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We have investigated the yield of gamma rays resulting from the bombardment of F^{19} by α particles.[1] Up to an α-particle energy of 2.8 Mev we observed only the 1.28-Mev γ ray of the reaction $F^{19}(\alpha,p)Ne^{22*}$, and the 114-kev and 200-kev radiations from the first and second excited states of F^{19} produced by inelastic scattering of the α particles. The γ rays were detected with a $1\frac{1}{2}$ in.$\times 1\frac{1}{2}$ in. sodium iodide scintillation spectrometer. The pulse spectrum was recorded with a 10-channel analyzer.

The yield of the 1.28-Mev γ ray shows a series of narrow resonances (first observable at $\sim$1.3 Mev) superimposed on a continuum. The yields of both resonances and continuum increase approximately exponentially with increasing energy. The 114- and 200-kev radiations also exhibit observable resonances above 2.0-Mev and 2.3-Mev, respectively. Below these energies the yields of the soft radiations decrease slowly as shown in Fig. 1. (The weak resonances at high energy have been omitted, their contribution to the total yield being negligible.) The absolute values of the cross sections have an estimated uncertainty of 20 percent arising chiefly from uncertainty in target thickness and stopping power. The 114-kev curve may have an additional uncertainty due to the difficulty of separating the 114-kev photopeak from the 200-kev spectrum; we may have underestimated the 114-kev yield by as much as 30 percent. On the other hand, the relative shape of each curve was reproducible to better than 10 percent for different targets and geometries.